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# Utilization of non-timber forest products in Panchamul-1, Andhikhola Rural Municipality, Syangja district, Nepal

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## ABSTRACT

The present paper documents the utilization of Non-Timber Forest Products in Panchamul-1, Andhikhola Rural Municipality, Syangja district of Nepal. It also determines the informant's knowledge and perception of medicinal plants, fodder plants, and wild edible plants utilized in the study area. The information regarding ethnobotany, fodder plants, and wild edible plants was collected through a pre-structured questionnaire survey, Key Informant Interview (KII), and Focus Group Discussion (FGD). Data based on ethnobotany were analyzed through Informant Consensus Factor (ICF), Fidelity Level (FL %), and use value (UV). Quality of fodder and the parts used of different Wild Edible Plants (WEPs) were based on informant knowledge and perception. In this study, a total of 111 plant species under 90 genera belonging to 59 families were recorded in Panchamul. Of which 62 species were used treating 64 ailments, where Cough/Cold ailment category has the highest ICF value (0.67) with 38 use reports and 13 plant species. Whereas, the least agreement was seen in the ailment category of Cuts/Wounds which have the lowest ICF value (0.0.43) with 15 use reports, 9 plant species. *Asparagus racemosus* has the highest FL (100%) used for Gastrointestinal complaints followed by *Halenia elliptica* (91.67%) used for fever, and *Lindera neesiana* (45.61%) has the lowest FL to cure Skeleto-muscular system problems. 12 fodder plants were identified as best fodder among 31 plants *viz. Artocarpus lacucha, Arundinaria falcate, Bauhinia purpurea, Dendrocalamus hamiltonii, Erythrina stricta, Ficus lacor, Ficus nemoralis, Ficus semicordata, Ficus subincisa, Premna bengalensis, Premna latifolia, and Quercus semecarpifolia.* Wild edible plants used in Panchamul-1 were mainly fruits (16) followed by leaves (11), tuber (06), etc. and these wild edible plants were mostly used for raw fruits (16), followed by vegetables (13), pickles (8) boil (5), spices (3), and jam (2). Based on ICF values, it is seen that there was a very high agreement in the usage of medicinal plants, which belongs to the cough/cold ailment category. Use value and fidelity level also indicate the most desired medicinal plant species used by the local inhabitants. Also, the informant's knowledge and perception regarding medicinal plants, fodder plants, and wild edible plants were well documented and it needs more in-depth research and conservation priority to those preferred plant, though these species were not seen harvested for trade in the study area.

**Keywords:** Edible plants, fodder plants, NTFPs, Medicinal Plants.

## 1. INTRODUCTION

Nepal is very rich in cultural as well as biological diversity, though a small country with an area of 147516 $Km^2$ hosts 10669 species of flora (Hara and William, 1979; Hara et al., 1978; Chaudhury, 1998). Altogether 336 species of flora are endemic to Nepal (Joshi and Joshi 1991; Shrestha and Joshi 1996; Chaudhury, 1998). Also, it stands in the $10^{th}$ position in having the highest diversity of flowering plants i.e. 6501 numbers in total (DPR, 2001). Nepal with such a rich floral diversity is not yet able to harness the benefits from the existing resource base (Subedi, 1997). In Nepal, both in-situ and ex-situ conservation and management of plant biodiversity are being practiced (Chaudhary 1998; Chaudhary et al. 2016) with very strong forest governance policies (MoEF, 2018). In Nepal 700 medicinal plants, 440 wild foods, 30 spices, and the other 71 are fibers yielding (Subedi et al., 2014).

NTFP is defined as "all products derived from biological resources found on forest land, but not including timber or fuelwood" (Wong, 2002). Depending on the objectives NTFPs are defined in either way as: 'non-timber forest product', 'non-wood forest product', 'wild products', 'natural products', 'non-timber forest and grassland products', 'minor forest products', 'secondary forest products', 'byproducts of the forest', 'non-traditional forest resources', 'non-timber trees product' or 'agroforestry products'(FAO, 1999). Rural communities of the developing country use NTFPs in a huge amount either for medicine, fodder, fertilizers, foods like fruits, nuts, honey, etc. construction materials, cosmetics, natural dyes, tannin, gums, aromatic oils, spices, edible oils, horns, decorative articles, bones, etc. These products can be derived from various sources such as plants (leaves, root, flower, stem, etc.), animals, and other non-living components of the ecosystem (Akanni, 2013). Sustainable utilization of NTFPs and its promotion could lead to poverty reduction, biodiversity conservation (FAO, 1995; Shiva and Verma, 2002; Golam et al., 2008), and hence maintaining the forest environmental services and biological diversity (Ros-Tonen, 2000). While some (Peters et.al., 1989) suggest that NTFP extraction is financially and ecologically sustainable, others point to its adverse social and ecological consequences (Arnold and Perez, 2001; SCBD, 2001). In developing countries like Nepal, any conservation program should be based on a broad understanding of landscape ecology (dynamics) and its drivers of social, economic, and ecological changes, which will not only replace but complement the conventional biodiversity conservation practice. Thus, the socio-economic well-being of the indigenous groups (Sayer 2009, Kremen and Merenlender, 2018).

Although, NTFPs, harvested for subsistence purposes (local use), exhibits little pressure. But commercially demanded NTFPs species are over-harvested (unsustainable harvesting) and it could lead to extinction threat. Often, NTFP species are overexploited because of their higher market values (Edward, 1994; Karki, 1996; Sharma, 1996), an unclear definition of property rights, a lack of knowledge on conservation, and increasing market demand (Subedi and Bhattarai, 1998). The Government of Nepal has endorsed acts, policies, plans, and legislative measures to regulate the collection, production, trade, processing, and marketing of NTFPs. However, the rules aren't regulated when NTFPs are harvested and traded. This study will emphasize the use-value and its importance of NTFPs the medicinal plants (ailment categories), fodder plants, and wild edible plants in the communities and stimulate the interest of the local inhabitants in the sustainable use and management of NTFPs.

## 2. MATERIALS AND METHODS

**Study Area**

Andhikhola is a Rural Municipality in Syangja Districts in the Gandaki Province of central Nepal. The total population of Aandhikhola is 16,589 with a total area of 69.61 $km^2$ (NPHC, 2011). It lies between $28^0$ 6′ N Latitude and $83^0$ 45′ E Longitude. Panchamul (Fig. 1) Ward-1 of this rural municipality comprises a total of 1079 households with a total of 6458 individuals (3175 female and 3283 male) as per the Panchamul ward office electoral roll report. The total area of Panchamul -1 is approximately 12.71 $km^2$ with (708 Acre) 2.87 $km^2$ forest cover.

**Data Collection**

The survey techniques and inventory techniques (Martin, 1995; Rastogi et al., 1998; Cunningham, 2001; Ghimire et al., 1999, 2000, 2001) were used for field data collection. Primary data were collected with an amalgam of survey methods including reconnaissance survey, participatory techniques- Focus Group Discussions (FGD), Key Informant Interview (KII), and formal & informal interviews. A simple random and purposive sampling method is used to administer the semi-structured questionnaire survey of households and on-site observations. The inventory technique by Transect walk survey was used for species identification by their local names and parts used, based on key informant's knowledge (Ghimire, et al., 1999, 2000, 2001). The NTFPs were also identified taking help of experts, taxonomist, and standard literature (Hara et. al., 1978, 1982; Hara and Williams, 1979; Polunin and Stainton, 1984; Stainton, 1988; Press et al., 2000; Lama et al., 2001; DPR, 2001; Zheng-yi et al., 1994).



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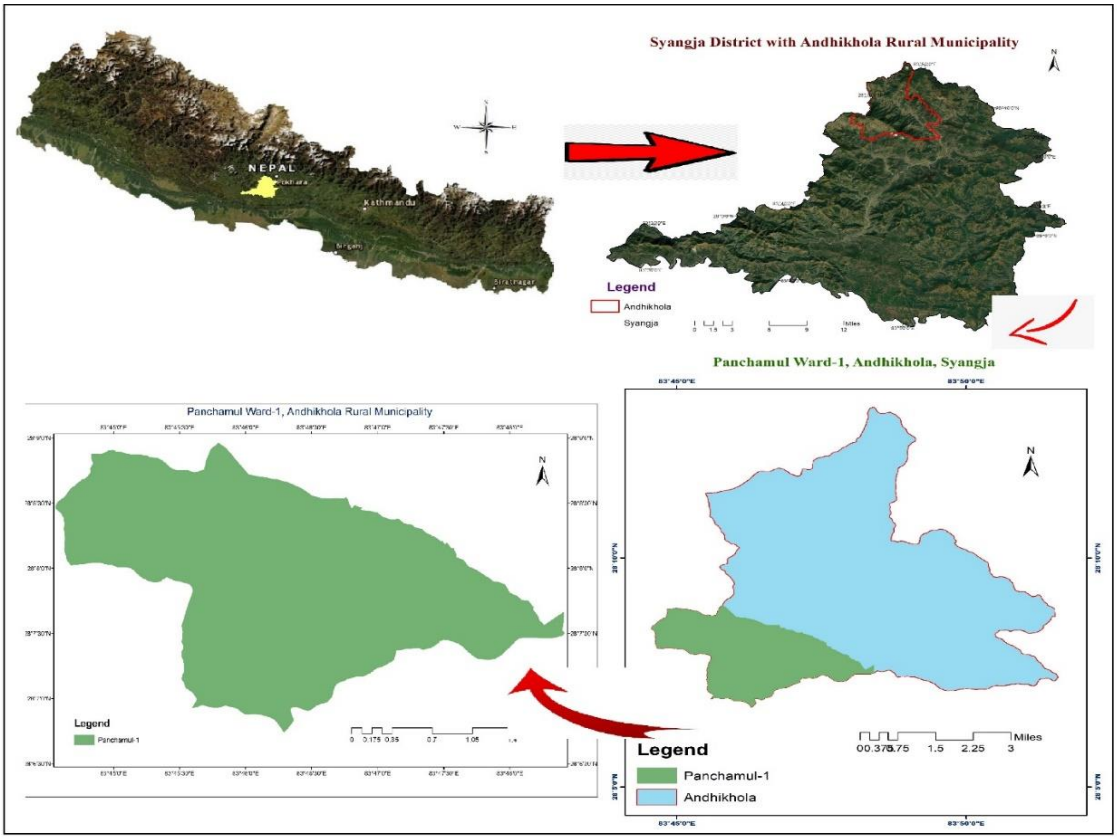


**Figure: 1. Study Area**

A formula based on (Cochran, 1977) was used to estimate the sample size (n) to administer the pre-structured questionnaire at a 95% confidence level.

$$\textbf{Sample Size (n)} = \frac{N*z^2*P(1-P)}{N*d^2*+z^2*P(1-P)},$$

Where 'n' is sample size with finite population correction, N is the population size, 'z' is z statistic for a level of confidence, 'P' is the expected proportion, and 'd' is the precision.

**Data Analysis**

The qualitative data were analyzed and described in the text. The quantitative data were analyzed in SPSS 16 and MS excel 2013. The results were presented in a table, pi-charts, and bar diagrams.

**Medicinal Used Value (UV)**

Plants species used as medicine and their relative importance was estimated with the help of formula on use value (UV) for $i^{th}$ species.

$$UVi = \frac{\Sigma Ui}{Ni}, \text{ (Phillips et al., 1994)}$$

Where $U_i$ is the number of use-reports cited by each informant for a given plant species i and $N_i$ is the total number of informants interviewed for a given plant species i. Use values are high when there are many use-reports for a plant and low when there are few reports related to its use.

**Informant Consensus Factor (ICF)**

Informant Consensus Factor (ICF) was used to estimate the general agreement (i.e. the relative homogeneity of use-reports) in the usage of medicinal plants in various ailments categories in the study area. The formula used to calculate ICF for the $j^{th}$ species is:



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$$ICFj = \frac{Nurj - Ntj}{Nurj - 1}$$, (Trotter and Logan, 1986; Heinrich et al., 1998)

Where $Nur_j$ is the number of use-reports in each ailment category *j* and $Nt_j$ is the total number of taxa used in each ailment category *j* by all informants. A higher value indicates a high rate of agreement, a low value indicates a low degree of agreement (Gazzaneo et al., 2005).

**Fidelity level (FL)**

In the study area, fidelity level (FL) was calculated to determine the frequently used plant species ($i^{th}$) by the local people for treating a specific ailment category (*j)* using the following formula:

$$\mathbf{FL}ij\ (\%) = \frac{\mathrm{Np}ij}{\mathrm{N}i} x\mathbf{100}\text{, (Friedman et al., 1986)}$$

Where Np*ij* is the number of use-reports cited for a given plant species i for a particular ailment category j and Ni is the total number of use-reports cited for any given species i. The highest FL*ij* value of plant species is considered a highly preferred species for ailment category j. Spearman's correlation coefficient (data were not normally distributed) was used to determine the correlations between use-value (UV) and fidelity level (%) for the medicinal plants documented in this study.

## 3. RESULTS AND DISCUSSIONS

A pre-structured questionnaire survey among 148 individuals and 28 key informants (18 Male and 10 Female) between ages 25 to 75 years was administered (Table 1). About 35% (10) were illiterate, 25% (7) had primary education, 32% (9) had secondary education, whereas, only 8% (2) were graduates. Among the 28 individuals selected key informants comprised of local healers (Brahmins) and farmers (Dalits, Gurungs, and Brahmins).

**Table 1: Gender and Age Class of the Key Informants**

| Gender | Informants Age class in Years | | | | | |
|---|---|---|---|---|---|---|
| | ≤30 | 31-40 | 41-50 | 51-60 | 61-70 | ≤75 |
| Female | 0 | 1 | 3 | 3 | 2 | 1 |
| Male | 1 | 3 | 4 | 3 | 4 | 3 |
| **Total** | **1** | **4** | **7** | **6** | **6** | **4** |

**Table 2: Medicinal Plants used by the resident of Panchamul, Andhikhola, Syangja**

| Botanical Name (Family) | Vernacular Name | Medicinal Plants | | | Similar Findings (references) |
|---|---|---|---|---|---|
| | | Parts | Treatment | $UV_i$ | |
| *Achyranthes bidentata* Bl. (Amaranthaceae) | Datiwin (Herb) | Ro, St | Toothache, Evil eyes | 0.75 | Thapa (2012) |
| *Aconitum spicatum* Staf. (Ranunculaceae) | Bikh (Herb) | Ro, L | Analgesic | 0.43 | Lama et al. (2001), Manandhar (2002) Joshi and Joshi (2001), and Baral and Kurmi (2006) |
| *Acorus calamus* L. (Araceae) | Bojho (Herb) | Ro | Toothache, Headache, Cough, Fever, Anti-fungal | 0.64 | Joshi and Joshi (2001) |
| *Amaranthus spinosus* L. (Amaranthaceae) | Lunde (Herb) | Ro, L | Over body heat | 0.43 | Thapa (2012) |
| *Anemone polyanthes D. Don* (Ranunculaceae) | Avijalo (Herb) | WP | Indigestion, Cough, Cold | 0.89 | Ghimire et al. (2001) |
| *Artemisia vulgaris* L. (Asteraceae) | Titepati (Shrub) | L | Antiseptic, Antibacterial and Antimicrobial | 0.75 | Rysdyk (2019) |
| *Asparagus racemosus* Wild. (Asparagaceae) | Kurilo (Climber) | Ro | Stomachache, constipation, anxiety, Breast milk production | 0.60 | Pizzorno, et al. (2015), Hechtman (2018), Goyal et al. (2003) |



ISSN 2278–5469 EISSN 2278–5450 I OPEN ACCESS

| | | | | | |
|---|---|---|---|---|---|
| *Berberis aristata* DC. (Berberidaceae) | Chutro (Shrub) | Fr, Br, L | Eye problems, Fever, Jaundice | 0.25 | Ghimire et al. (2001), Rajbhandari (2001), Lama et al. (2001), Manandhar (2002), Baral and Kurmi (2006) and Kunwar et al. (2006) |
| *Bergenia ligulata* (Wall.) (Saxifragaceae) | Phakanbed (Herb) | Ro, Rh | Fever, Anti-diabetic, Lowers Blood Pressure, Kidney stone. | 0.18 | Gurav and Gurav (2014) |
| *Calotropis gigantea* (L.) (Apocynaceae) | Ankh (Shrub) | Lx | Blood Clot, Fracture | 0.18 | Bhattarai, et al., (2009) |
| *Choerospondias axillaris* (Roxb.) B. L. Burtt & A. W. Hill (Anacardiaceae) | Lapsi (Tree) | Fr, Br | Anti-oxidant, Secondary burn | 0.36 | Wang et al. (2008), Nguyen et al. (1996). |
| *Centella asiatica* (L.) Urban (Apiaceae) | Ghodtapre (Herb) | WP | Anxiety, Common cold and flu, Diarrhea, Fatigue, Hepatitis, Indigestion, Jaundice, Tonsillitis, Urinary tract infection, wound healing | 1.00 | Shrestha and Dhillion, (2003), Tamang, (2003), Bhattarai, et al., (2009), Joshi, et al., (2011), Thapa, (2012) |
| *Cheilanthes dalhousiae* Hook. (Pteridaceae) | Dankasnu (Fern) | L | Gastritic | 0.31 | Thapa (2012) |
| *Cinnamomum tamala* (Buch.-Hum.) Ness & Eberm. (Lauraceae) | Tejpatta (Tree) | L | Stomach Gas, Stomachache, Diarrhea, Allergy, Cough and Cold | 0.57 | Hasan et al. (2013) |
| *Crateva unilocularis* Buch.-Ham. (Capparaceae) | Siplikaan (Tree) | L | Stomach ache, Bad cholesterol, Blood pressure, Fever, Urinary Problems | 0.39 | Manandhar (2002) |
| *Curcuma caesia* Roxb. (Zingiberaceae) | Kalo Haledo (Herb) | Rh | Dysentery, Back pain | 0.50 | Thapa (2012) |
| *Curcuma zedoaria (Christm.) Roscoe (*Zingiberaceae) | Seto Haledo (Herb) | Rh | Dysentery, Back Pain | 0.57 | Thapa (2012) |
| *Drynaria propinqua* (Wall. ex Mett.) J.Sm. ex Bedd. (Polypodiaceae) | Kammari Laharo (Climber) | St, L | Bone Fracture | 0.75 | Chang et al. (2007) |
| *Eupatorium adenophorum* Spreng. (Compositae) | Banmara (Shrub) | L | Antiseptic, Blood Coagulant | 0.93 | Thapa (2012) |
| *Euphorbia hirta L.* (Euphorbiaceae) | Dodhe Jhar (Herb) | Ro | Antiseptic, Blood Coagulant, Skin Burn, Piles | 0.78 | Thapa (2012) |
| *Euphorbia royleana* Boiss. (Euphorbiaceae) | Siudi (Shrub) | Lx | Skin diseases | 0.28 | |
| *Ficus semicordata* Buch.-Ham. ex Sm.( Moraceae) | Khanyu (Tree) | L | Scabies | 0.43 | Thapa (2012) |
| *Fragaria nubicola* Lindl. ex Lacaita (Rosaceae) | Bhui Aiselu (Herb) | Fr, L | Skin Rashes (Herpes zoste) | 0.57 | Thapa (2012) |
| *Girardinia diversifolia* a (Link) Friis (Urticaceae) | Chalne Sisnu (Herb) | Ro | Swollen body, Internal injury, Blood purification | 0.25 | Manandhar (2002), Kunwar et al. (2006) and Ghimire et al. (2001) |
| *Gonostegia hirta* (Bl.) Miquel | Chiple Ghas | WP | Dislocated Bone | 0.28 | Thapa (2012) |



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| | | | | | |
|---|---|---|---|---|---|
| (Urticaceae) | (Herb) | | | | |
| *Halenia elliptica* D. Don (Gentianaceae) | Tite (Herb) | L, St | Fever, Headache, Cough And Cold | 0.78 | Rajbhandari (2001), Pohle (1990), Chophel (1993), Dawa (1993) |
| *Houttuynia cordata* Thunb. *(Saururaceae)* | Gandhe (Herb) | WP | Stomachache, Gastric, Boost appetite | 0.68 | Yang and Jiang (2009) |
| *Jatropa curcus* L. (Euphorbiaceae) | Sajiwan (Shrub) | Lx | Toothache, Anti-microbial | 0.25 | Patil et al., (2013) |
| *Juniperus indica* Bertol *(Cupressaceae)* | Dhupi (Shrub) | L, Fr | Cough and Cold, Skin Diseases, Incense | 0.28 | Phole (1990), Joshi and Joshi (2001), Baral and Kurmi (2006) and Kunwar et al. (2006) |
| *Lagerstroemia parviflora* Roxb. (Lythraceae) | Dhaiyanro (Tree) | F | Dysentery (Blood stool) | 0.18 | |
| *Lindera neesiana* (Wall. ex Nees) Kurz (Lauraceae) | Siltimur (Tree) | S | Cough, Cold, Headache | 0.93 | Thapa (2012) |
| *Lycopodium clavatum* L. (Lycopodiaceae) | Nagbeli (Herb) | WP, Sp | Cough, Rheumatism, Gastric, Constipation, Fever | 0.14 | Bharadwaj and Mishra (2018) |
| *Lyonia ovalifolia* (Wall.)Drude. (Ericaceae) | Angeri (Shrub) | L, B | Skin disease | 0.21 | Manandhar (2002) |
| *Mirabilis jalapa* L. (Nyctaginaceae) | Seto Malati (Herb) | Ro | Menstrual Problem, Dysentery, Headache, Earache | 0.38 | Boullard (2001) |
| *Morus alba* L. (Moraceae) | Kafal (Tree) | Ro | Intestinal worm | 0.11 | Thapa (2012) |
| *Myrica esculenta* Buch.-Ham. ex. D. Don (Myricaceae) | Ban Kafal (Tree) | Fr, Br, L | Asthma, Cough, Chronic Bronchitis, Ulcers, Constipation, Anemia, Fever, Diarrhea, And Ear, Nose, And Throat Disorders. | 0.32 | Kumar and Rana (2013), Sood and Shri (2018) Shrestha and Dhillion, (2003), Tamang and Sedai (2016) |
| *Nardostachys grandiflora* DC. (Valerianaceae) | Jatamansi (Herb) | Rh | Headache, Cough, Cold, Fever, | 0.71 | Ghimire et al. (2001), Kunwar et al. (2006) |
| *Opuntia monacantha* Haw. (Cactaceae) | Paate Siundi | WP | Burns, Wounds, Indigestion, Diabetes | 0.78 | Hasan (2018) |
| *Oxalis corniculata* L (Oxalidaceae) | Amilo Jhar (Herb) | WP | Sinus, Stomach Problems, Appetite | 0.93 | Thapa (2012) |
| *Parmelia nepalensis* Tayl. (Parmeliaceae) | Jhyau (Lichen) | WP | Menstrual Disorder | 0.43 | NEHHPA |
| *Periploca calophylla* (Wight) Falc. (Asclepiadaceae) | Sikari Lahara (Climber) | WP | Fractured Bone, Body ache, Backache | 0.28 | Adhikari, et al. (2019) |
| *Phyllanthus emblica* L. (Euphorbiaceae) | Amla (Tree) | Fr | Cough, Sore Throat, Constipation, Diarrhea, Gastritis | 0.96 | Bhattarai, et al., (2009), Luitel, et al. (2014), Tamang and Sedai (2016) |
| *Pogostemon plectranthoides* Desf. (Lamiaceae) | Rudilo (Herb) | Ro, | Fever | 0.43 | Dangol (2008) |
| *Polypodium vulgare* L. (Polypodiaceae) | Bikhfage (Fern) | Rh | Constipation, Diarrhea | 0.28 | Camps et al. (1990) |
| *Prunus cerasoides* D. Don (Rosaceae) | Paiyun (Tree) | Br | Barks are cut into pieces, boiled and decoction is | 0.25 | Manandhar (2002) |



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| | | | | | |
|---|---|---|---|---|---|
| | | | applied externally on swollen and burnt body parts. | | |
| *Psidium guajava* L. (Myrtaceae) | Amba (Tree) | L, Br | Anthelmintic, Stomachache, Blood stool | 0.78 | Bhattarai, et al., (2009), Malla and Chhetri (2009), Luitel, et al. (2014), Tamang and Sedai (2016) |
| *Rhododendron arboretum* Sm. (Ericaceae) | Lali Guras (Tree) | L, Br | Headache, Jaundice, Diabetes, liver disorders, and Intestinal worms | 0.64 | Rawat et al. (2017) |
| *Rosa serisea* Lindl. (Rosaceae) | Bhote Gulab (Herb) | Fl | Headache | 0.21 | Manandhar (2002) |
| *Rubia manjith* Roxb. ex Fleming (Rubiaceae) | Majhitho (Climber) | Ro | Fever, Chest Pain, Dysentery, Rheumatism | 0.14 | Ghimire et al. (2001), Manandhar (2002) |
| *Rubus ellipticus* Sm. (Rosaceae) | Aniselu (Shrub) | WP | Gastric, Sinusitis | 0.43 | Shrestha and Dhillion, (2003), Thapa (2012), Luitel, et al. (2014), Tamang and Sedai (2016), Joshi, et al., (2011) |
| *Rumex nepalensis* Spreng. (Polygonaceae) | Halhale (Herb) | Ro, L | Constipation, Diarrhea, Vegetable/Pickle | 0.39 | Manandhar (2002), Kunwar et al., (2006) |
| *Selinum tenuifolium* Wall. ex C.B. Clarke (Apiaceae) | Bhutkase (Herb) | WP, Ro | Traditional Magico-Religious beliefs | 0.14 | Umberto, (2012) |
| *Solanum capsicoides* All. (Solanaceae) | Kantakari (Herb) | Fr | Toothache, | 0.25 | Thapa (2012) |
| *Swertia chirayita* (Roxb. ex Fleming) Karsten. (Gentianaceae) | Chiraito (Herb) | WP | Cough, Cold, Fever, Malaria, and Headache | 0.32 | Rajbhandari (2001), Manandhar (2002), Rokaya et al., (2010) |
| *Tectaria coadunata* (Wall. ex Hook. & Grev.) C.Chr (Tectariaceae) | Kalo Nuro (Fern) | Rh | Dysentery | 0.38 | Thapa (2012) |
| *Tinospora sinensis* (Lour.) Merr. (Menispermaceae ) | Gurjho (Climber) | St | Mensuration, Diabetes, Arthritis, Immunostimulant Diarrhea, Dysentery | 0.78 | Tamang, (2003), Bhattarai, et al., (2009 |
| *Trichosanthes tricusoidata* Lour. (Cucurbitaceae) | Indrayani (Tree) | Fr | Asthma, Earache, Rheumatism | 0.43 | Dubey et al. (2012). |
| *Tropaeolum majus L.* (Tropaeolaceae) | Barahmase (Climber) | L, Fl | Sinusitis | 0.28 | Thapa (2012) |
| *Urtica dioica* L. (Urticaceae) | Sisnu (Herb) | L, St, Ro | Chest Problems, Gastritis, Cuts & Wounds, Fractured & Broken Bones | 0.78 | Rajbhandari (2001), Ghimire et al. (2001), Manandhar (2002),Kunwar et al. (2006), Rokaya (2010) |
| *Valeriana jatamansi* Jones (Caprifoliaceae) | Sugandhawal (Herb) | WP | Dysentery, Diarrhea, Headache, Cough, and Indigestion. | 0.32 | Ghimire et al. (2001) and Kunwar et al. (2006) |
| *Vitex negundo* L. (Lamiaceae) | Simali (Shrub) | L, S, Ro | Menstrual Problem, Analgesic, Fever | 0.25 | Wan Hassan (2010), Kumar et al. (2018) |
| *Zanthoxylum armatum* DC (Rutaceae) | Timur (Shrub) | B, C, Fr, S | Toothache, Gastric | 0.88 | Thapa (2012), Hasan et al. (2013) |
| C= Carpels, Br=Bark, B-Bulb, L=Leaves, WP=Whole Plant, St=Stem, Fr=Fruit, Ro=Root, Lx=Latex, S=Seed, Fl=Flower, Sp=Spores, $UV_i$= Use value ($i^{th}$ Species) | | | | | |



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In this study, a total of 111 plant species under 90 genera belonging to 59 families were recorded in Panchamul, treating 64 ailments. Out of the total plant species, 62 species were used as medicinal plants, 31 species were fodder plants, and 41 species were wild edible plant species. A total of 62 medicinal plants under 59 genera belonging to 42 families were recorded (Table 2). Among the recorded families Euphorbiaceae (4), Rosaceae (4), and Polygonaceae (3) had the highest species counts (Fig. 2). During the treatment process, it is seen that leaves (21) were the most used followed by roots (14), whole plants (11), fruits (9), bark and rhizomes (6), etc. (Fig. 3). The results based on ICF (Informant Consensus Factor) showed that the value ranges from 0.43-0.67, where the Cough/Cold ailment category has the highest value i.e. ICF-0.67, 38 use reports, 13 plants species (*Centella asiatica* FL=73.68%, *Phyllanthus emblica* FL=71.05%, and *Lindera neesiana* FL=68.42% holds the highest Fidelity level) followed by Respiratory System Disorder category i.e. ICF- 0.66, 13 use reports, 5 plant species (*Trichosanthes tricusoidata* FL=92.31%, and *Myrica esculenta* FL=69.23% holds the highest Fidelity level) and then Circulatory System Disorders category i.e. ICF- 0.63, 42 use reports, 16 plant species (*Eupatorium adenophorum* FL=61.90%, and *Psidium guajava* FL=52.38% holds the highest Fidelity level). The least agreement was seen in ailment category of Cuts/Wounds i.e. ICF-0.0.43, 15 use reports, 9 plant species (*Centella asiatica* FL= 88.23%, *Opuntia monacantha* FL=68.18 %, and *Urtica dioica* FL=68.18 hold the highest Fidelity level) followed by Dermatological Infections category i.e. ICF- 0.44, 19 use reports, 11 plant species (*Artemisia vulgaris* FL=90.50%, *Euphorbia hirta* FL=86.36%, *Opuntia monacantha* FL=86.36%, and *Fragaria nubicola* FL=84.21% holds the highest Fidelity level) (Table 3). A similar study in Rasuwa district, Central Nepal (Uprety et al., 2010) reported disorders related to kidney problems, toothache, and ophthalmic problems showed the highest ICF of 1.0, and the lowest values were found for gastro-intestinal ailments category with an ICF of 0.53 and a study in Humla district, Western Nepal (Rokaya et al., 2010) reported Gastro-intestinal ailments category showed the highest ICF of 0.40, and the lowest values were found for Ophthalmological uses (ICF-00) followed by Respiratory system disorders (ICF-0.06). Similar studies from India and Thailand have reported much higher ICF values as mentioned in our study (Shristi et al., 2009; Rajkumar and Shivanna, 2009). Traditional use of specific medicinal plants and their knowledge were seen transferring orally to the young generation without any methodical process (Bussmann and Sharon, 2006) from generation to generation. These findings were supported by many studies (Joshi and Edington, 1990; Jain and Saklani, 1991; Shrestha and Dhillion, 2003; Rajkumar and Shivanna, 2009: Uprety et al., 2010; Panging and Sharma, 2017).

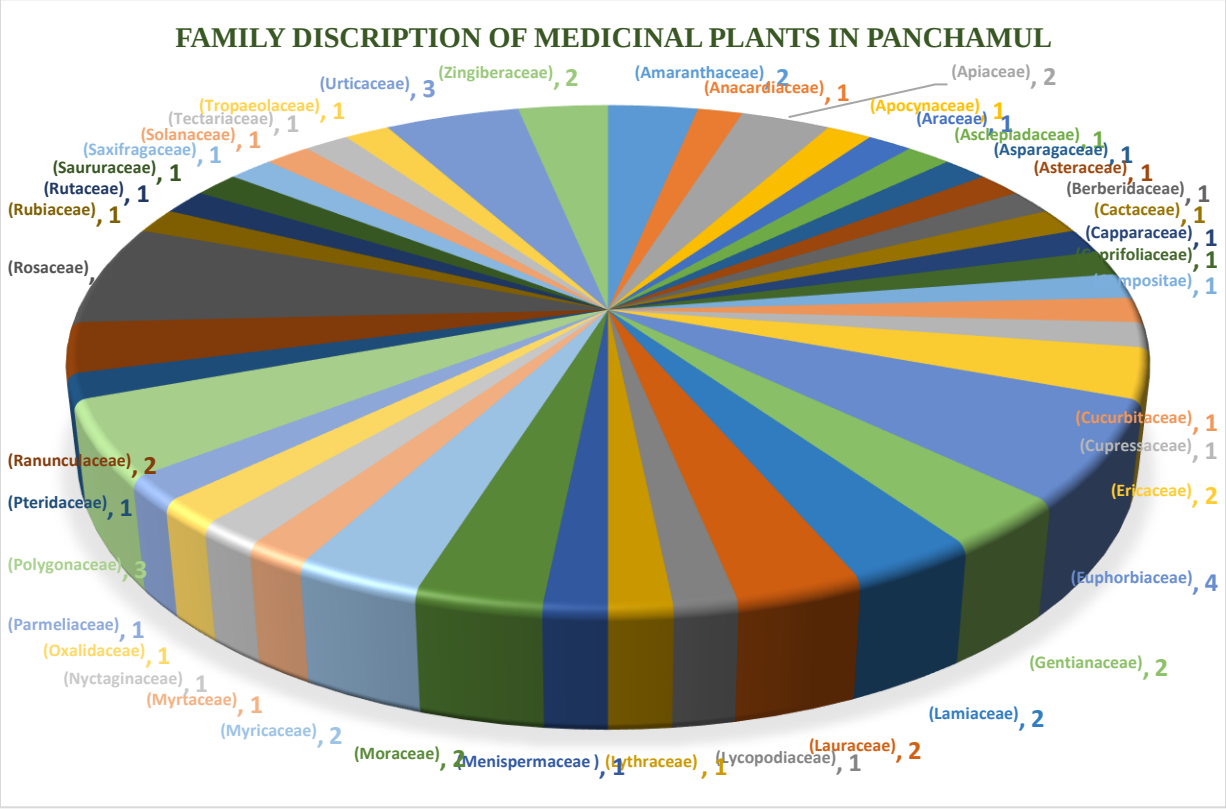


**Fig 2: Families descriptions of available medicinal plants in Panchamul**

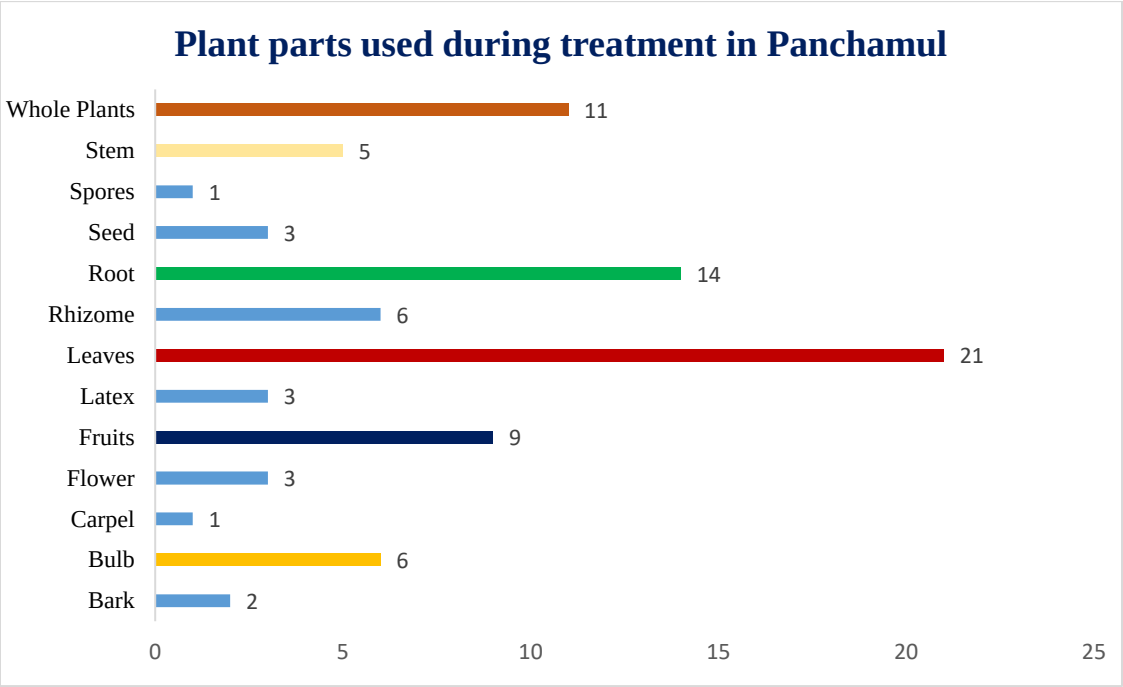


**Fig 3: Plants parts for treatment of various ailments**

| Table 3: Ailments (Categories) and informant consensus factor (ICF) and highest fidelity level | | | | |
|---|---|---|---|---|
| **Ailments (Categories)** | **$Nur_j$** | **$Nt_j$** | **ICF** | **FL (%)** |
| **Circulatory system disorders** | 42 | 16 | 0.63 | |
| *Eupatorium adenophorum* | | | | 61.90 |
| *Psidium guajava* | | | | 52.38 |
| **Cough/cold** | 38 | 13 | 0.67 | |
| *Centella asiatica* | | | | 73.68 |
| *Phyllanthus emblica* | | | | 71.05 |
| *Lindera neesiana* | | | | 68.42 |
| **Cuts/wounds** | 15 | 9 | 0.43 | |
| *Centella asiatica* | | | | 88.23 |
| *Opuntia monacantha* | | | | 68.18 |
| *Urtica dioica* | | | | 68.18 |
| **Dermatological infections** | 19 | 11 | 0.44 | |
| *Artemisia vulgaris* | | | | 90.50 |
| *Euphorbia hirta* | | | | 86.36 |
| *Opuntia monacantha* | | | | 86.36 |
| *Fragaria nubicola* | | | | 84.21 |
| **Ear, nose and throat (ENT) problems** | 21 | 10 | 0.55 | |
| *Oxalis corniculata* | | | | 87.50 |
| *Centella asiatica* | | | | 80.95 |
| **Fever** | 24 | 11 | 0.56 | |
| *Halenia elliptica* | | | | 91.67 |
| *Nardostachys grandiflora* | | | | 83.33 |
| **Gastro-intestinal ailments** | 83 | 46 | 0.46 | |
| *Asparagus racemosus* | | | | 100 |
| **Genito-urinary ailments** | 17 | 7 | 0.62 | |



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| | | | | |
|---|---|---|---|---|
| *Crateva unilocularis* | | | | 64.70 |
| *Centella asiatica* | | | | 60.71 |
| **Respiratory system disorders** | 13 | 5 | 0.66 | |
| *Trichosanthes tricusoidata* | | | | 92.31 |
| *Myrica esculenta* | | | | 69.23 |
| **Skeleto-muscular system problems** | 57 | 31 | 0.46 | |
| *Lindera neesiana* | | | | 45.61 |
| **Others/ Unclassified** | 9 | 5 | 0.50 | |
| *Choerospondias axillaris* | | | | 90.00 |
| *Berberis aristata* | | | | 77.78 |
| *Jatropa curcus* | | | | 77.77 |
| Total | 338 | 164* | | |

* *A taxon may be reported in more than one ailment category,* FL= Fidelity level, Nur =Number of use-reports, Nt =Number of taxa

**Table 4: Fodder Plants used by the resident of Panchamul, Andhikhola, Syangja**

| Botanical Name (Family) | Vernacular Name | Quality of Fodder |
|---|---|---|
| *Aesandra butyracea* (Roxb.) Baehn (Sapotaceae) | Chiuree | Fair |
| *Albizia procera* Roxb. Benth. (Leguminosae) | Siris | Fair |
| *Artocarpus lacucha* Buch.-Ham. (Moraceae) | Badahar | Best |
| *Arundinaria falcata* Nees (Gramineae) | Neeyalo | Best |
| *Bauhinia purpurea* L. (Leguminosae) | Tanki | Best |
| *Bauhinia variegata* L. (Leguminosae) | Koiralo | Good |
| *Brassaiopsis hainla* Buch.-Ham. Seem. (Araliaceae) | Chuletro | Good |
| *Buddleja asiatica* Lour. (Loganiaceae) | Phurse | Good |
| *Buddleja paniculata* Wall. (Loganiaceae) | Narayan Patti | Good |
| *Dalbergia sissoo* Roxb. (Leguminosae) | Sisou | Fair |
| *Dendrocalamus hamiltonii* Nees and Arn. (Gramineae) | Bans | Best |
| *Duabanga grandiflora* (Roxb.exDC.)Walp. (Lythraceae) | Lampate | Fair |
| *Engelhardia spicata* Leschen. Ex Blume (Juglandaceae) | Mahuwa | Fair |
| *Erythrina stricta* Roxb. (Leguminosae) | Phaledo | Best |
| *Ficus hispida* L.f. (Moraceae) | Tote | Good |
| *Ficus lacor* Buch.- Ham. (Moraceae) | Kavro | Best |
| *Ficus nemoralis* Wall. ex Miq. (Moraceae) | Dudhilo | Best |
| *Ficus semicordata* Buch.-Ham. ex Smith (Moraceae) | Khaneyu | Best |
| *Ficus subincisa* Buch.- Ham. Ex Smith (Moraceae) | Bidilno | Best |
| *Fraxinus floribunda* Wall. (Oleaceae) | Lankuri | Fair |
| *Melia azedarach* L. (Meliaceae) | Bakaino | Fair |
| *Morus australis* Poir. (Moraceae) | Kafal | Good |
| *Morus alba L.* (Moraceae) | Kimbu | Good |
| *Myrica esculenta* Buch.- Ham. ex D.Don (Myricaceae) | Ban Kaphal | Fair |
| *Premna bengalensis* C.B. Clarke (Verbenaceae) | Kalo Geeneri | Best |
| *Premna latifolia* Roxb. Var. Mucronata (Verbenaceae) | Seto Geeneri | Best |
| *Prunus cerasoides* D. Don (Rosaceae) | Painyu | Good |
| *Quercus semecarpifolia* Smith (Fagaceae) | Kharsu | Best |
| *Rhus javanica* L. (Anacardiaceae) | Bhakimlo | Fail |
| *Schefflera venulosa* Weight and Arn. Harm. (Araliaceae) | Kutsimal | Good |
| *Toona ciliata* M. Roem. (Meliaceae) | Tooni | Fair |



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| Table 5: Wild edible Plants used by the resident of Panchamul, Andhikhola, Syangja | | |
|---|---|---|
| **Botanical Name (Family)** | **Vernacular Name** | **Parts Used-For** |
| *Amaranthus spinosus* L. (Amaranthaceae) | Lunde (Herb) | **L- Veg** |
| *Artocarpus lacucha* Buch.-Ham. (Moraceae) | Badahar (Tree) | F-Fruit, Veg |
| *Bambusa bambos* (L.) Voss. (Poaceae) | Bans (Bamboo) | Young Shoot |
| *Berberis asiatica* Roxb. ex DC. (Berberidaceae) | Chutro (Shrub) | Berry-Fruit |
| *Castanopsis indica* (Roxb. Ex Lindl.) A.DC (Fagaceae) | Katoosh (Tree) | Nut-fruit |
| *Centella asiatica* (L.) Urb. (Apiaceae) | Ghodtapre (Herb) | L- Pic |
| *Chenopodium album L. (*Chenopodiaceae*)* | Bethe (Herb) | L- Veg |
| *Choerospondias axillaris* (Roxb.) (Anacardiaceae ) | Lapsi (Tree) | F-Fruit, Jam, Pic |
| *Cinnamomum tamala* Buch.- Ham. T.N.& E.(Lauraceae) | Tejpatta (Tree) | *L- Spi* |
| *Colocasia esculenta* (L.) Schott. (Araceae) | Pindalu (Herb) | Root/Tuber- Veg |
| *Crateva unilocularis* Buch.-Ham. (Capparaceae) | Siplikaan (Tree) | Shoot,L,F-Veg |
| *Curcuma aromatica* Salisb. (Zingiberaceae) | Ban Haledo (Herb) | Rh- Spi |
| *Dendrocalamus hamiltonii* Nees & Arn ex M. (Poaceae) | Tama (Bamboo) | Shoot- Veg, Pic |
| *Dioscorea alata* L. (Dioscoreaceae) | GharTarul(Climber) | Tuber- Boil, Veg |
| *Dioscorea bulbifera* L. (Dioscoreaceae) | Githa (Climber) | Tu/Ro-Boil, Veg |
| *Dioscorea esculenta* Lour. (Dioscoreaceae) | Bantarul(Climber) | Root/tuber-Boil, Veg |
| *Dioscorea hamiltoni*i Hook.f. (Dioscoreaceae) | Bantarul (Climber) | Tu/Ro-Boil, Veg |
| *Dioscorea oppositifolia* L. (Dioscoreaceae) | Ban tarul (Climber) | Tuber- Boil |
| *Drymaria cordata* (L.) Willd. Ex Schult. (Caryophyllaceae) | Abhijalo (Herb) | L- Veg |
| *Euphorbia royleana* Boiss. (Euphorbiaceae) | Saudi (Shrub) | F- Veg |
| *Ficus benghalensis* L. (Moraceae) | Bar (Tree) | F-Fruit |
| *Ficus glaberrima* Blume (Moraceae) | Pakhri (Tree) | F-Fruit |
| *Ficus sarmentosa* Buch.-Ham. Ex Sm. (Moraceae) | Ban timilo (Tree) | Fig-Fruit |
| *Ficus semicordata* Buch.-Ham. ex Sm. (Moraceae) | Khaneyu (Tree) | F- Ripe fruit |
| *Fragaria nubicola* Lindl. Ex Hook.f. (Rosaceae) | Bhui Aiselu (Shrub) | Berry- Fruit |
| *Justicia adhatoda* L. (Acanthaceae) | Asuro (Shrub) | F,L,Fl- Veg, Pic |
| *Lantana camara* L. (Verbenaceae) | Ban Phanda (Shrub) | F- Fruit |
| *Lecanthus peduncularis* Wall. ex R.) Wedd. (Urticaceae) | Khole (Herb) | L-Veg |
| *Manihot esculenta* Crantz (Euphorbiaceae) | Simal Tarul (Shrub) | Tuber- Boil |
| *Mentha spicata* L. (Lamiaceae) | Pudina (Herb) | L- Pic |
| *Morus alba L.* (Moraceae*)* | Kafal (Tree) | Berry-Fruit |
| *Myrica esculenta* Buch.-Ham. Ex D. Don (Myricaceae) | Ban Kafal (Tree) | F-Fruit, Pic |
| *Nephrolepis cordifolia* (L.) C. Prest (Nephrolepidaceae) | Pani amala (Herb) | Tuber-Root |
| *Phyllanthus emblica* L. (Phyllanthaceae) | Amla (Tree) | F- Fruit, Pic |
| *Prunus cerasoides* D. Don (Rosaceae) | Paiyun (Tree) | F-Ripe Fruit |
| *Psidium guajava* L. *(Myrtaceae)* | Amba (Tree) | F-Fruit |
| *Rhododendron arboreum* Sm. (Ericaceae) | Laligurash (Tree) | Juice, Jam |
| *Rubus barberi* H.E.Weber (Rosaceae) | Ainselu (Shrub) | Berry-Fruit |
| *Rumex nepalensis* Spreng. (Polygonaceae) | Halhale (Herb) | L-Veg |
| *Urtica dioica* L. (Urticaceae) | Sisnu (Herb) | L- Veg |
| *Zanthoxylum armatum* DC. (Rutaceae) | Timur (Shrub) | F-Fruit, Pic, Spi |
| L=Leaves, F=Fruit, Veg= Vegetable, Pic=Pickle, Tu/Ro=Tuber/Root, Rh=Rhizome, Spi=Spices, Fl=Flower | | |



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The correlation between plant use value (UV) and the highest fidelity level (%) in the categorized ailments was found significant (Spearman's Correlation test; $r_p$ =0.493, p(2-tailed)= 5E-05) which indicated that by normal standards, the association between use-value (UV) and fidelity level (%) are necessarily those used commonly by the indigenous people of the region.

31 Fodder plant species under 23 genera belonging to 15 families were documented in the study area. Among these Moraceae (8) had the maximum number of species followed by Leguminosae (5), Araliaceae (2), Gramineae (2), Loganiaceae (2), Verbenaceae (2), and the rest with single species each (Fig 4). Out of them, 12 species were categorized as best fodder plants, 09 species as good, and 10 species as fair based on farmer priority and preferences (Table 4). The research reported by (Dhungana et al., 2012; Samant et al., 2007; Upreti and Shrestha, 2006; Panthi, 2003, 2013, Sharma et al., 2016a) were also in close conformity to this study.

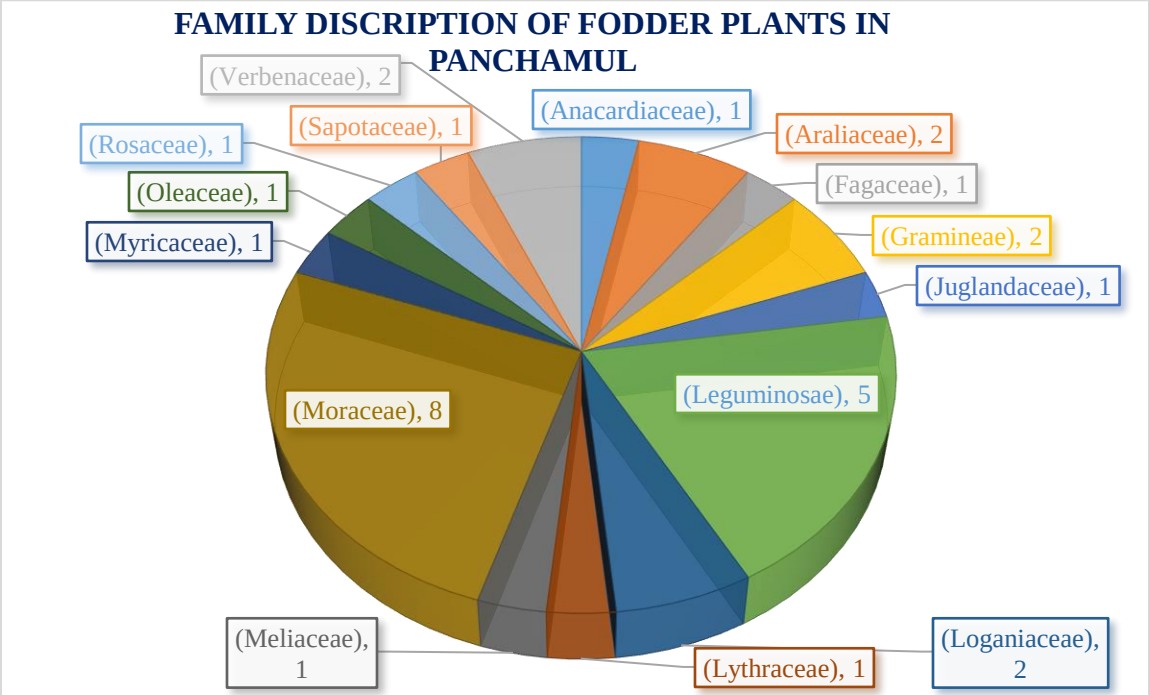


**Fig 4: Family description of fodder plants in Panchamul**



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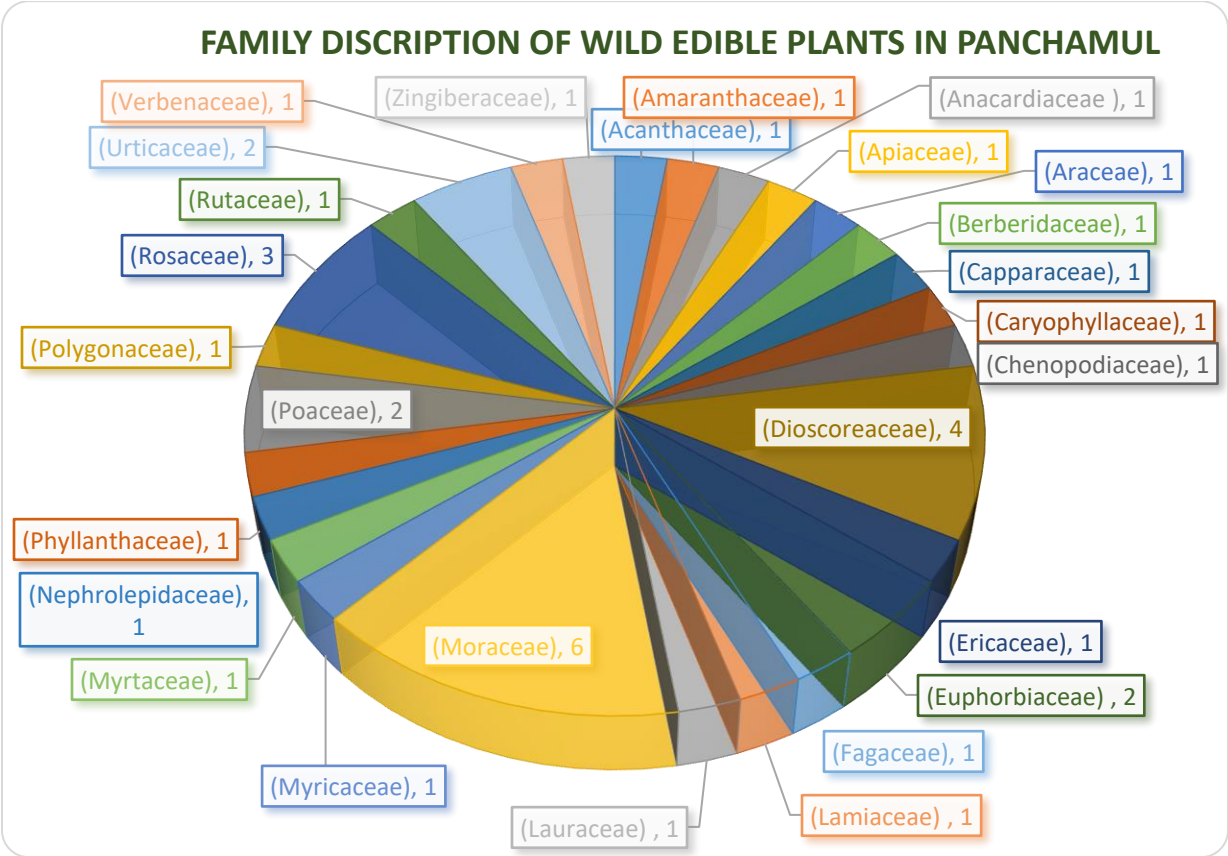


**Fig 5: Family description of wild edible plants in Panchamul**

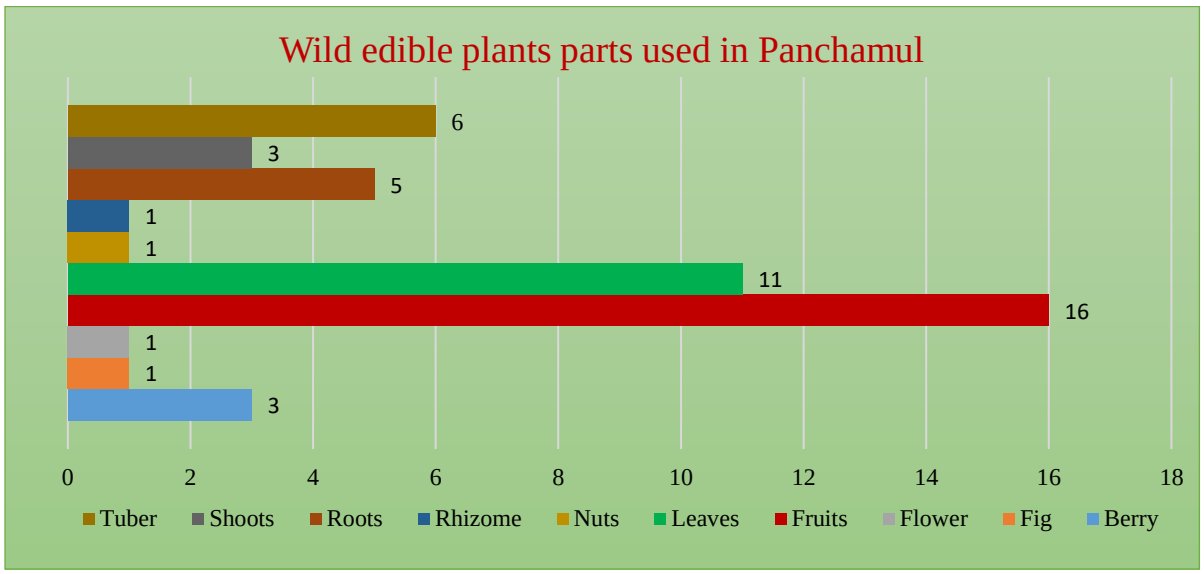


**Fig 6: Parts of wild edible plants used in Panchamul**



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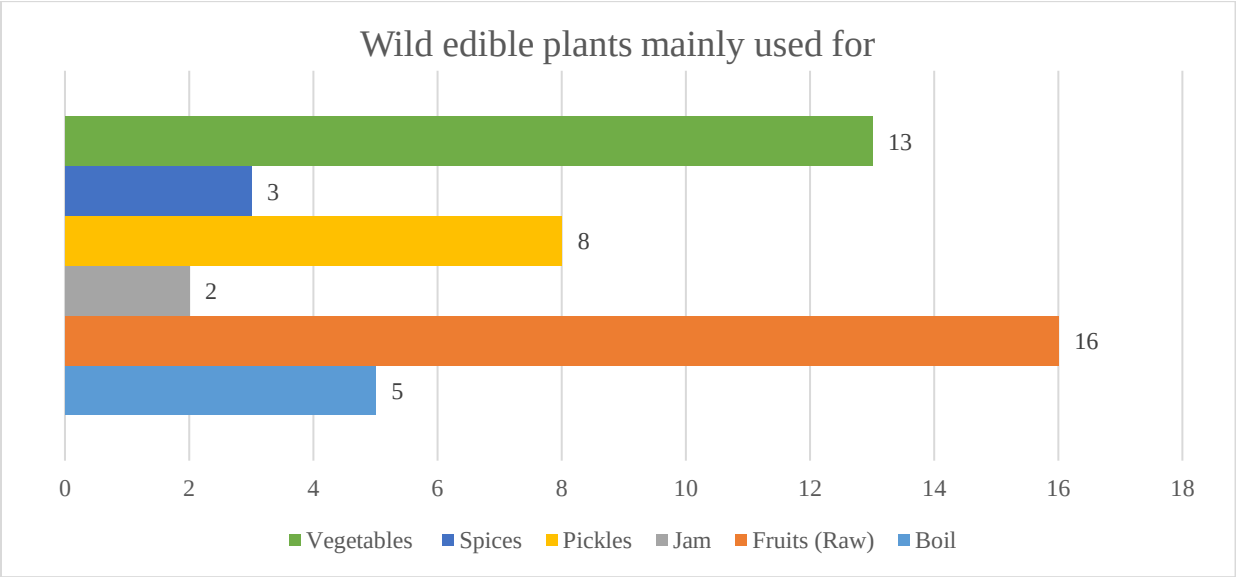


**Fig 7: Wild edible plants mainly used for in Panchamul**

Also, this research has listed 41 wild edible plants belonging to 34 genera and 27 families (Table 5). Of the total families, the dominant is Moraceae (6 Spp.) followed by Dioscoreaceae (5 Spp.), Rosaceae (3 Spp.), Poaceae, Euphorbiaceae, & Urticaceae (2 spp. each), and rest 21 families have one species each (Fig. 5). Wild edible plants used in Panchamul were mainly for fruits (16) followed by leaves (11), tuber (06), root (05), berry (03), rhizome, nuts, and fig (01 each) (Fig. 6). Also, it is estimated that wild edible plants were mainly used for raw fruits (16), followed by vegetables (13), pickles (8) boil (5), spices (3), and jam (2) (Fig. 7). Similar findings were reported in the research by (Bajracharya 1980; Dangol and Gurung 2000; Dangol 2002, 2010; Joshi et al 2007; Acharya and Acharya, 2010; Ghimireya et al 2010; Uprety et al 2012; Shrestha 2013; Dangol et al 2014; Sharma et al., 2016b; Sharma et al., 2017; Khakhalary and Sharma, 2017).

## 4. CONCLUSION

Panchamul-1 of Andhikhola Rural Municipality is very rich in Non-Timber Forest Products, but more in-depth research exploration is needed. Like, studies on the phytochemical exploration of medicinal plants and their phytotherapeutic shreds of evidence. Though the study area has the best kind of fodder species and numerous wild edible plants, unsustainable harvesting of such plants may cause serious scarcity of fodder and depletion of wild edible plants in the region. It is thus recommended that especially for the most important plant species, a proper cultivation technique should be formulated and conservation and management perspectives should be adopted. Also, medicinal plants with low use-value and fidelity levels should not be overlooked which may lead to the gradual loss of indigenous knowledge. Thus, NTFPs in rural communities should be looked at as a means of livelihood and source of income through sustainable management of the same.

**Conflict of interest**

The authors declare that they have no conflict of interest.

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**Data and materials availability**

All data associated with this study are present in the paper.

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